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SUMMARY of TROPICAL CYCLONE ACTIVITY and FORECASTS in the 1996-7 SOUTHERN HEMISPHERE SEASON

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JUNE 1998

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1. INTRODUCTION

A summary of tropical cyclone activity in the southern hemisphere for the 1996-7 season is presented below together with an assessment of the performance of the global model in predicting the tracks of these tropical cyclones.

Tropical cyclones are experienced in the South Indian Ocean, tropical seas to the west, north and east of Australia and the western South Pacific Ocean. For the purpose of tropical cyclone verification the southern hemisphere is divided in to two basins; the South-West Indian (west of 90°E) and Australian (east of 90°E). Mean error statistics for each basin are presented together with a table of statistics for the whole southern hemisphere. The global model produces a 6-day forecast every 12 hours. Verification is performed at 24 hour intervals up to forecast time T+120.

The global model resolution during the season was 1.25°x 0.83°x 19 levels. This is equivalent to a horizontal resolution of 139km x 93km at the equator. The tropical cyclone verification scheme identifies the centre of a tropical cyclone in the model by locating a local maximum of relative vorticity at 850hPa. A surface fitting technique is used to locate the centre accurately.

The terms used in the statistics tables are explained below :-

Possibly verified - No. of forecasts fulfilling requirements 1, 2 & 4 below.
Detection Rate - Percentage of possibly verified forecasts which also fulfil requirement 3 below.
Mean DX - Mean of positional errors in the East-West direction.
Mean DY - Mean of positional errors in the North-South direction.
Mean AT - Mean of positional errors in the Along Track direction.
Mean CT - Mean of positional errors in the Cross Track direction.
Skill - Percentage skill of model against CLIPER.
Mean DPE - Mean of direct positional errors.
All errors are measured in kilometres except where indicated.

(*) 1. Observed maximum wind at least 31 knots at the verifying time.
2. Forecast tropical cyclone centre equatorwards of 45 degrees.
3. Forecast tropical cyclone centre relative vorticity above a critical limit for verification (0.55×10^{-4} per second).
4. Observation within 6 hours of verifying time present for use in verification.

Forecast skill is defined as:-
(CLIPER DPE - Model DPE) / CLIPER DPE x 100%

Positive skill indicates the model forecast is better than CLIPER.
Negative skill indicates the CLIPER forecast is better than the model.

A diagrammatic explanation of other error statistics and their sign conventions can be found in Appendix A. Full details of the TC verification scheme can be found in nwp Gazette, Vol.1, No.2, December 1994.

Advisory positions primarily from JTWC Guam are used as verifying observations of storm location when track verification is carried out immediately after a storm has ended. Best track data from RSMCs La Réunion and Nadi, Fiji, Bureau of Meteorology, Australia and Met. Service, New Zealand have been obtained for this season's storms and the track forecasts verified again. Statistics for verification against best-track observations are presented in detail. Some statistics for verification against real-time observations (from JTWC, Guam and RSMC, Fiji) are included for the purposes of a comparison. Some mean error statistics for last season are also included for the purposes of a comparison. Forecast tracks are only verified when a depression reaches tropical storm status.

2. TROPICAL CYCLONE ACTIVITY

	SWI	AUS	TOTAL
Total number active 1995-6	10 (10)	18 (17)	28 (27)
Total number active 1996-7	15 (15)	24 (24)	39 (39)

Basin name abbreviations:- SWI = South-West Indian (west of 90°E)
AUS = Australian (east of 90°E)

The number in brackets indicates the number of depressions which reached tropical storm status (maximum sustained wind above 33 knots).

3. SUMMARY OF ALL SOUTHERN HEMISPHERE STORMS

3.1 South-West Indian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	176	146	116	90	68	49
Detection Rate (%)	100	93	85	88	84	78
Mean DX	-19	-98	-160	-206	-173	-17
Mean DY	21	41	50	-1	-35	-141
Mean AT	0	3	41	24	3	-73
Mean CT	9	2	-46	-88	-109	-72
Mean Skill (%)	****	-8	9	22	****	****
1995-6 Skill (%)	****	-10	16	25	****	****
Mean DPE	84	217	351	458	559	606
1995-6 DPE *	93	185	318	427	525	732
RT DPE #	63	222	353	459	560	609

* DPE for all South-West Indian storms in 1995-6 season
\# DPE calculated using real time observations as opposed to best track.

Comments :
A plot of the observed tracks of all storms in this basin can be found in Fig. 1.

There was near to 50% more activity this season in the South-West Indian basin compared to last season. Analysis and T+120 forecast errors were smaller than last season, but errors at all other forecast times were slightly higher. Skill scores were near to or slightly lower than last season. Figs. 2 and 3 show forecast errors and skill scores for the last few seasons. Despite slightly larger errors than the previous two seasons, the errors were still below the figures for 1993-4 and earlier seasons. There were no significant biases in model forecasts.

3.2 Australian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	273	226	185	151	120	89
Detection Rate (%)	100	100	97	94	93	94
Mean DX	-7	-73	-166	-194	-174	-138
Mean DY	17	34	24	34	80	71
Mean AT	-7	-53	-93	-107	-78	-140
Mean CT	1	-40	-102	-106	-63	-47
Mean Skill (%)	****	27	41	43	****	****
1995-6 Skill (%)	****	10	20	-15	****	****
Mean DPE	73	200	319	461	592	703
1995-6 DPE *	91	203	297	553	782	1148
RT DPE #	64	206	322	466	595	711

* DPE for all Australian storms in 1995-6 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

A plot of the observed tracks of all storms in this basin can be found in Figs. 4 and 5.

There were near to 40% more storms in the Australian basin this season than last and the storms persisted much longer. There were more than four times the number of T+72 forecasts to verify. Forecast errors at T+72 and beyond were significantly lower than last season and skill scores were 17-58% higher. Figs. 6 and 7 show forecast errors and skill scores for the last few seasons. There was a small slow bias in forecasts.

3.3 Combined Statistics for whole Southern Hemisphere

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	449	372	301	241	188	138
Detection Rate (%)	100	97	92	92	90	88
Mean DX	-12	-82	-164	-198	-174	-100
Mean DY	18	37	33	22	41	5
Mean AT	-4	-32	-45	-61	-51	-119
Mean CT	4	-25	-82	-100	-78	-55
Mean Skill (%)	****	15	30	36	****	****
1995-6 Skill (%)	****	1	18	13	****	****
Mean DPE	77	206	330	460	581	673
1995-6 DPE *	92	194	309	472	594	824
RT DPE #	63	212	333	464	583	679

* DPE for all southern hemisphere storms in 1995-6 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

Figs. 8 and 9 show forecast errors and skill scores and Figs. 10 and 11 along-track and cross-track errors over the last few seasons .

The combined statistics for the whole southern hemisphere indicate that forecast errors were slightly higher than last season's figures at early forecast times, but slightly lower at later times. Skill scores showed a 12-23% improvement. After rising last season, along-track errors reduced significantly this season and cross-track errors remained at a consistent level.

There was little difference between figures derived using real-time and best track data.

Further Tropical Cyclone Information

The Met. Office pages on the World Wide Web contain information on tropical cyclone forecasting at the Met. Office. Monthly bulletins of tropical cyclone activity and forecasts are held together with observed and forecast track information of recent storms, track prediction error statistics, lists of names, images, movies and photographs and details of advances made in tropical cyclone track prediction at the Met. Office.

The Met. Office web site is:- **http://www.met-office.gov.uk**
Tropical Cyclone information can be found under the section "The weather & how we forecast it".

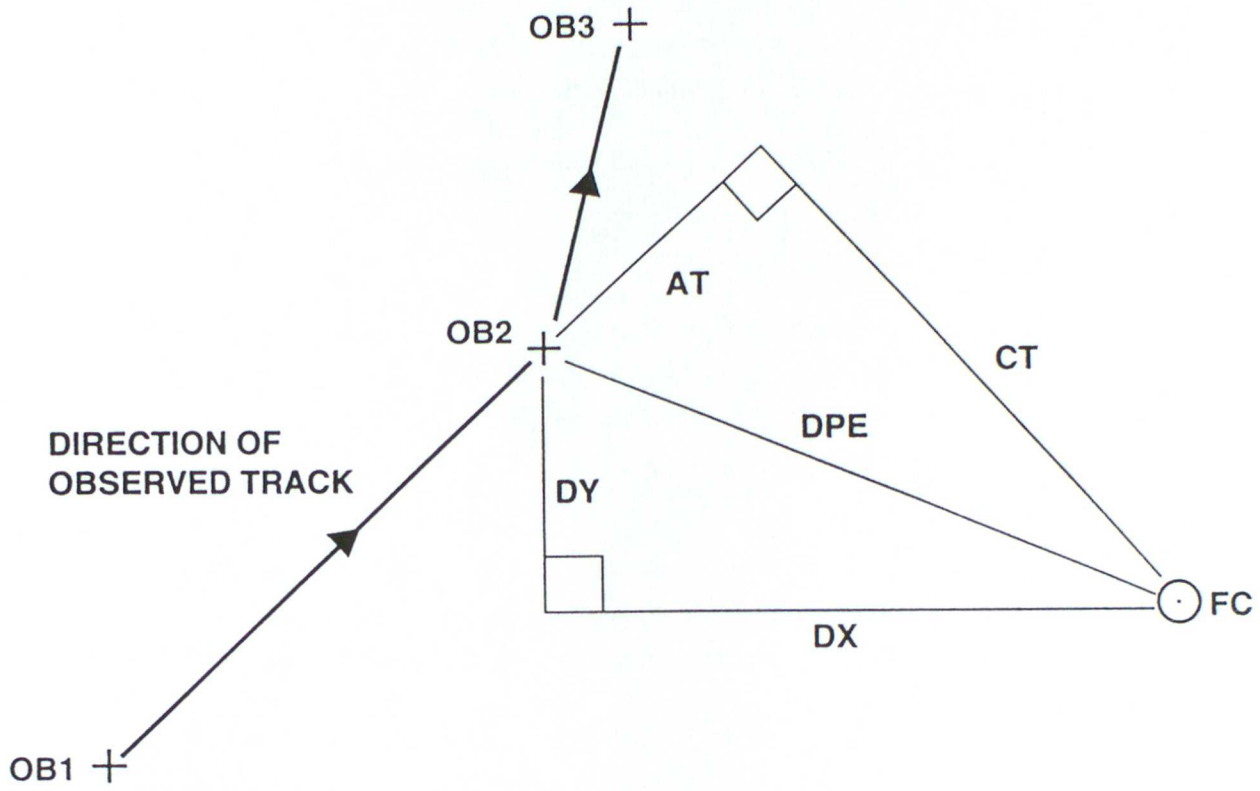
The information above is also available on *Metnet* under Julian Heming's home page. Contact Julian Heming (jheming@meto.gov.uk) for further information on tropical cyclone forecasting at the Met. Office.

Acknowledgements

CLIPER models for various basins were supplied by Mr.S.Lord, NMC, Washington, USA and Mr.C.Mauck, FNOC, Monterey, USA.
GrADS software used to produce track plotting charts was supplied by Mr.S.Lord and Dr.M.Fiorino.
Best track observations for the southern hemisphere were supplied by RSMC Météo-France, La Réunion, Bureau of Meteorology, Australia, RSMC Nadi, Fiji and Met. Service Ltd, New Zealand.

APPENDIX A

Diagrammatic Explanation of Forecast Errors



OB1-3 : Observed positions
FC : Forecast position verifying against observation OB2
DPE : Direct positional error
DX : Error in the East-West direction
DY : Error in the North-South direction
AT : Error in the Along Track direction
CT : Error in the Cross Track direction

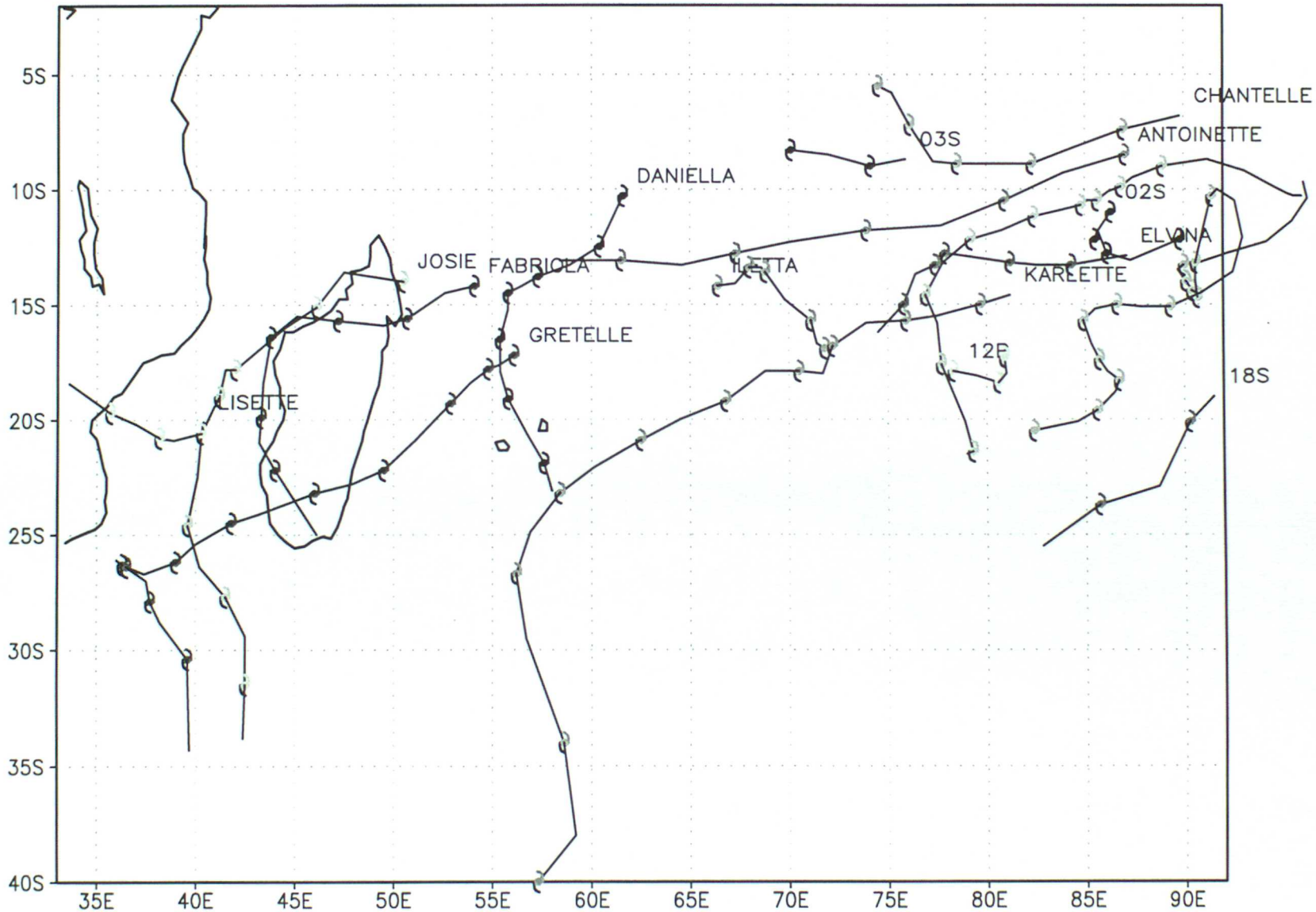
All errors are measured in kilometres

Sign Conventions

DPE values are always positive.
DX errors are positive if the forecast position lies eastwards of the observed position.
DY errors are positive if the forecast position lies polewards of the observed position.
AT errors are positive if the forecast position lies ahead of the observed position along the tropical cyclone track.
CT errors are positive if the forecast position lies right of the observed track in the northern hemisphere and left of the observed track in the southern hemisphere.

Figure 1

OBSERVED TRACKS of TROPICAL CYCLONES in the SOUTH–WEST INDIAN BASIN



02S 960817 03S 960908 ANTOINETTE 961017 BELLAMINE 961030 CHANTELLE 961125 DANIELLA 961203
ELVINA 961210 FABRIOLA 970103 12P 970110 18S 970112 PANCHO 970120 GRETELLE 970121
ILETTA 970124 JOSIE 970209 KARLETTE 970217 LISETTE 970228

KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS

SYMBOLS REPRESENT 00Z POSITIONS

Figure 2

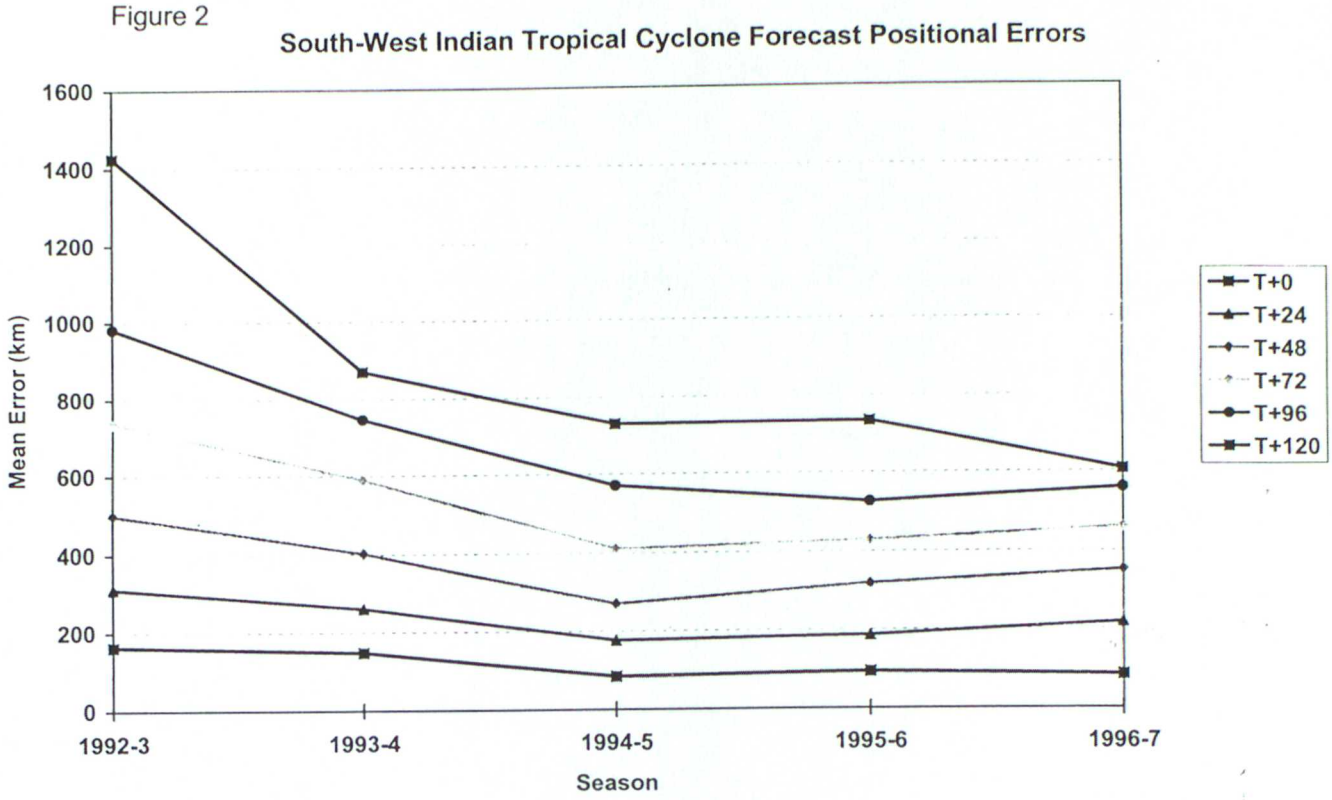


Figure 3

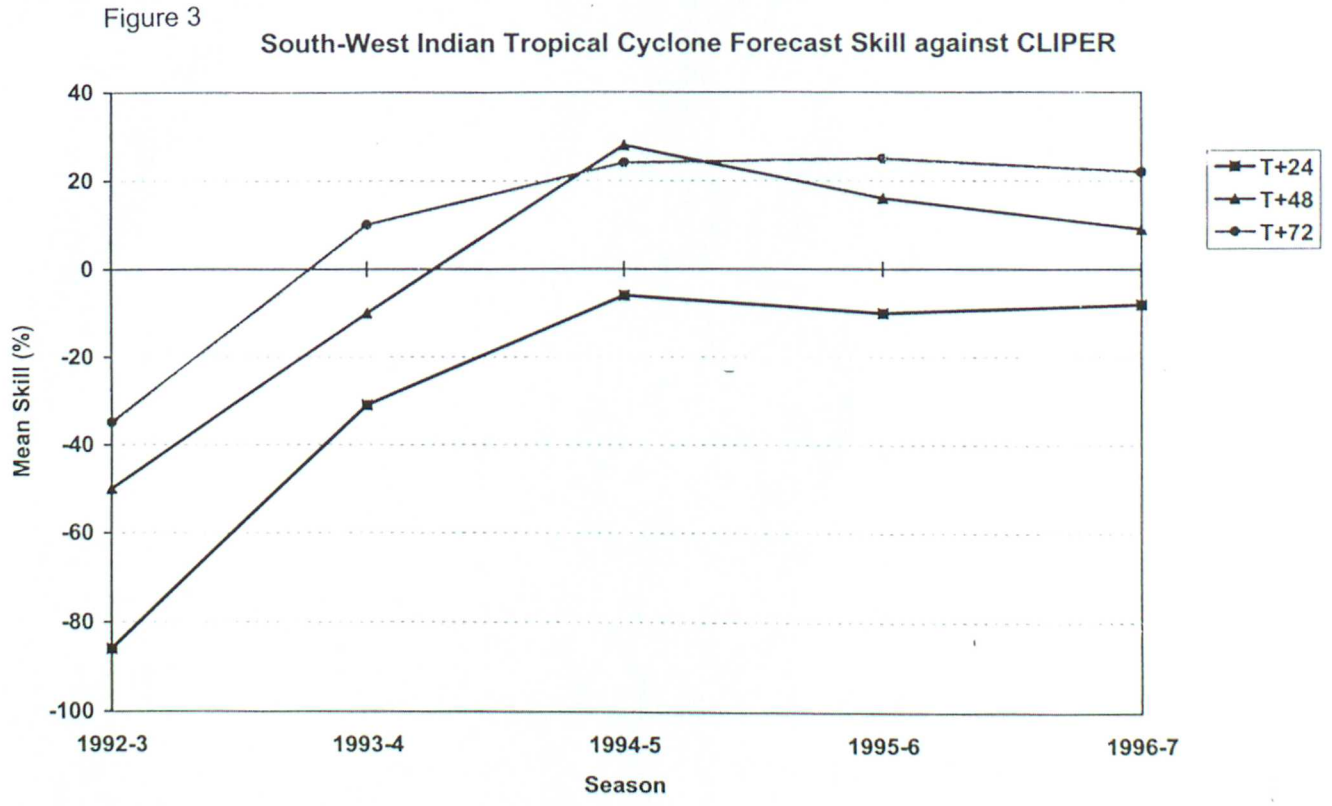
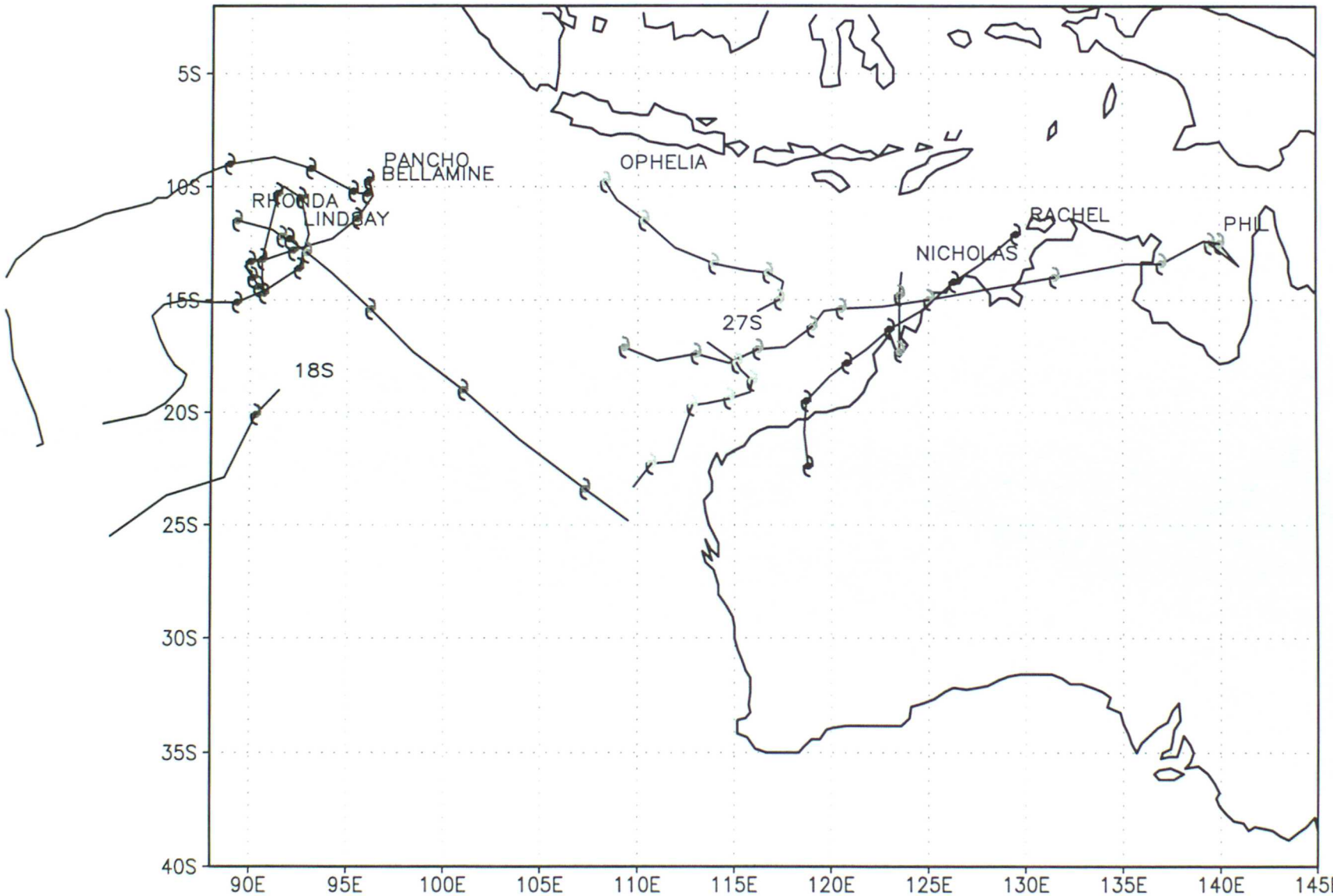


Figure 4

OBSERVED TRACKS of TROPICAL CYCLONES in the WESTERN AUSTRALIAN BASIN



LINDSAY 960711 BELLAMINE 961030 NICHOLAS 961214 OPHELIA 961215 PHIL 961224 RACHEL 970103
18S 970112 PANCHO 970120 27S 970220 RHONDA 970511
KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS
SYMBOLS REPRESENT 00Z POSITIONS

Figure 5

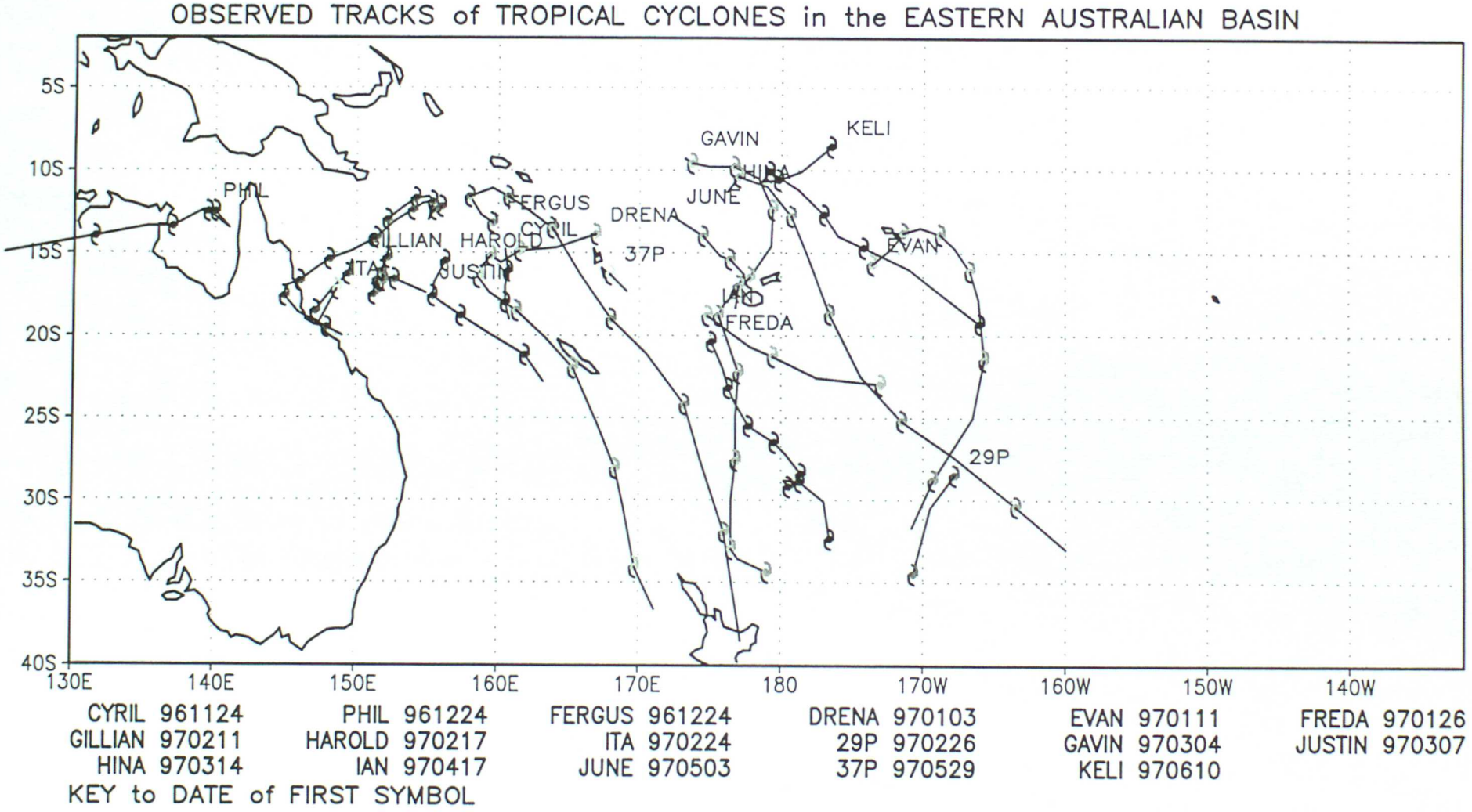

OBSERVED TRACKS of TROPICAL CYCLONES in the EASTERN AUSTRALIAN BASIN
5S
10S
15S
20S
25S
30S
35S
40S
130E
140E
150E
160E
170E
180
170W
160W
150W
140W
PHIL
GILLIAN
HAROLD
ITA
JUSTIN
FERGUS
CYRIL
DRENA
37P
GAVIN
HINA
JUNE
KELI
IAN
FREDA
EVAN
29P
CYRIL 961124
GILLIAN 970211
HINA 970314
PHIL 961224
HAROLD 970217
IAN 970417
FERGUS 961224
ITA 970224
JUNE 970503
DRENA 970103
29P 970226
37P 970529
EVAN 970111
GAVIN 970304
KELI 970610
FREDA 970126
JUSTIN 970307
KEY to DATE of FIRST SYMBOL
24 HOURLY BEST TRACK OBSERVED POSITIONS
SYMBOLS REPRESENT 00Z POSITIONS

Figure 6

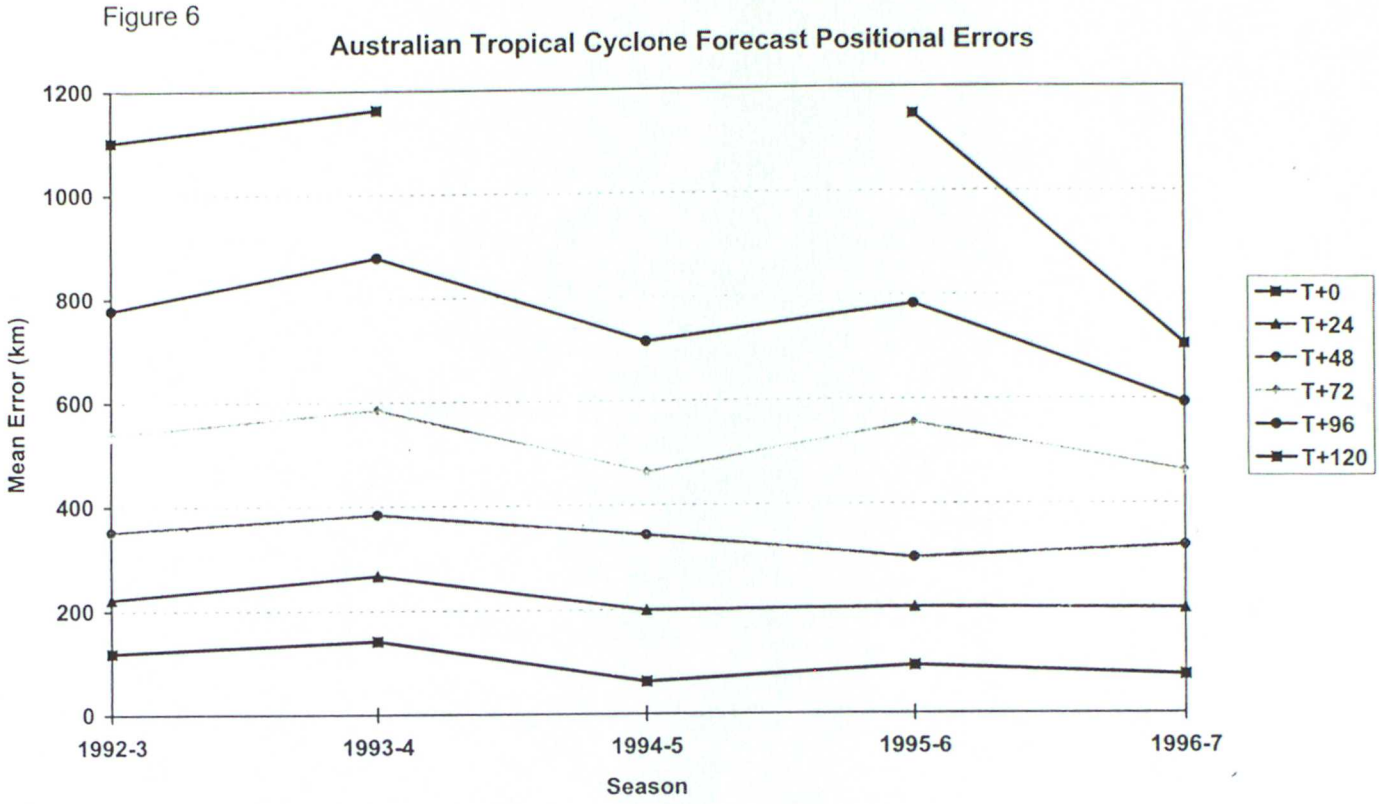


Figure 7

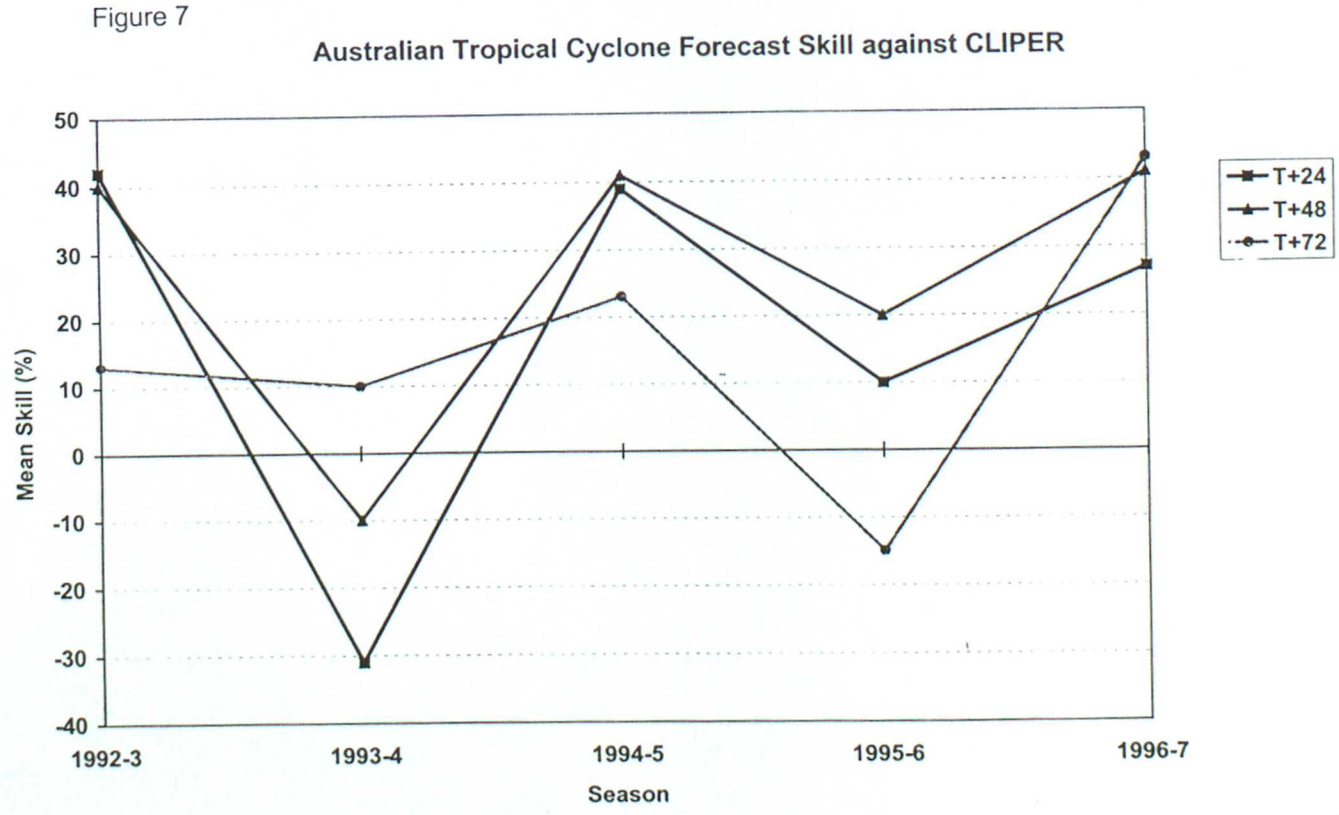


Figure 8

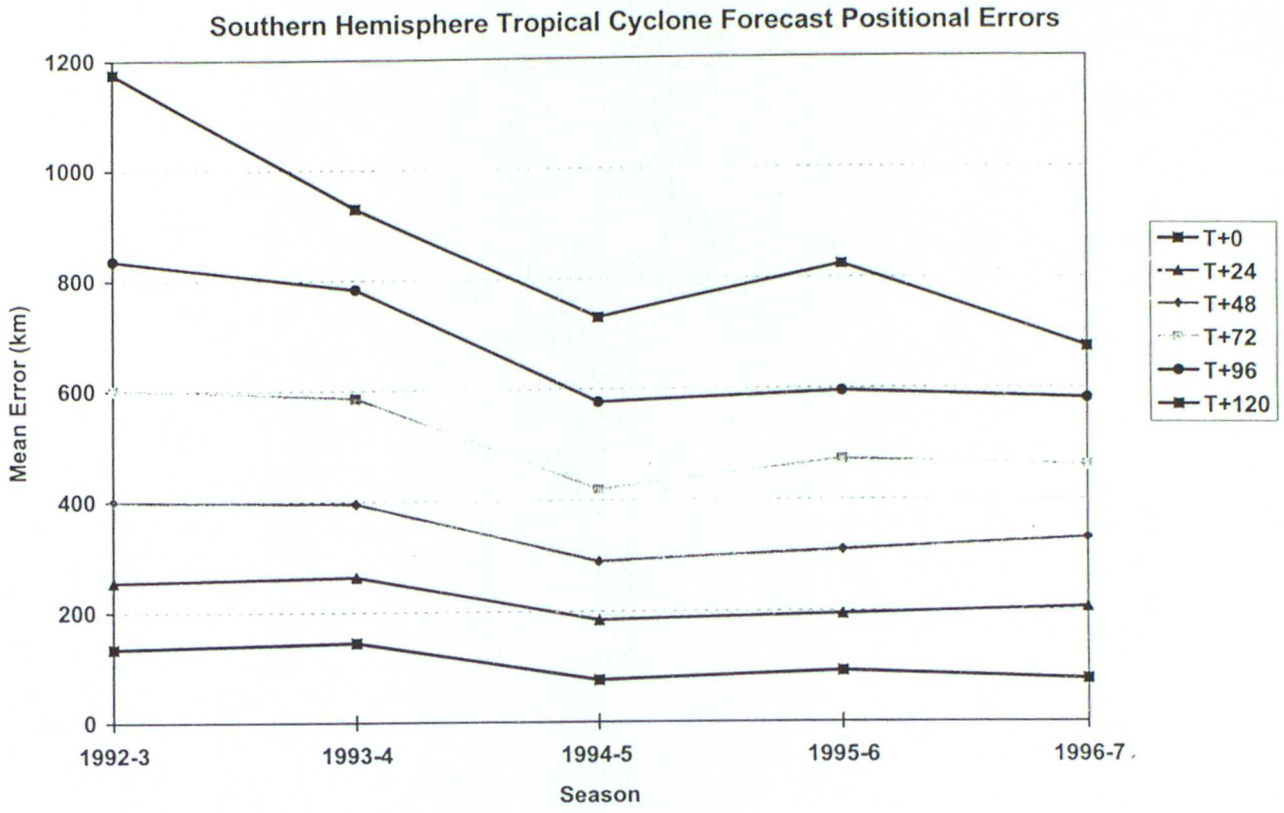


Figure 9

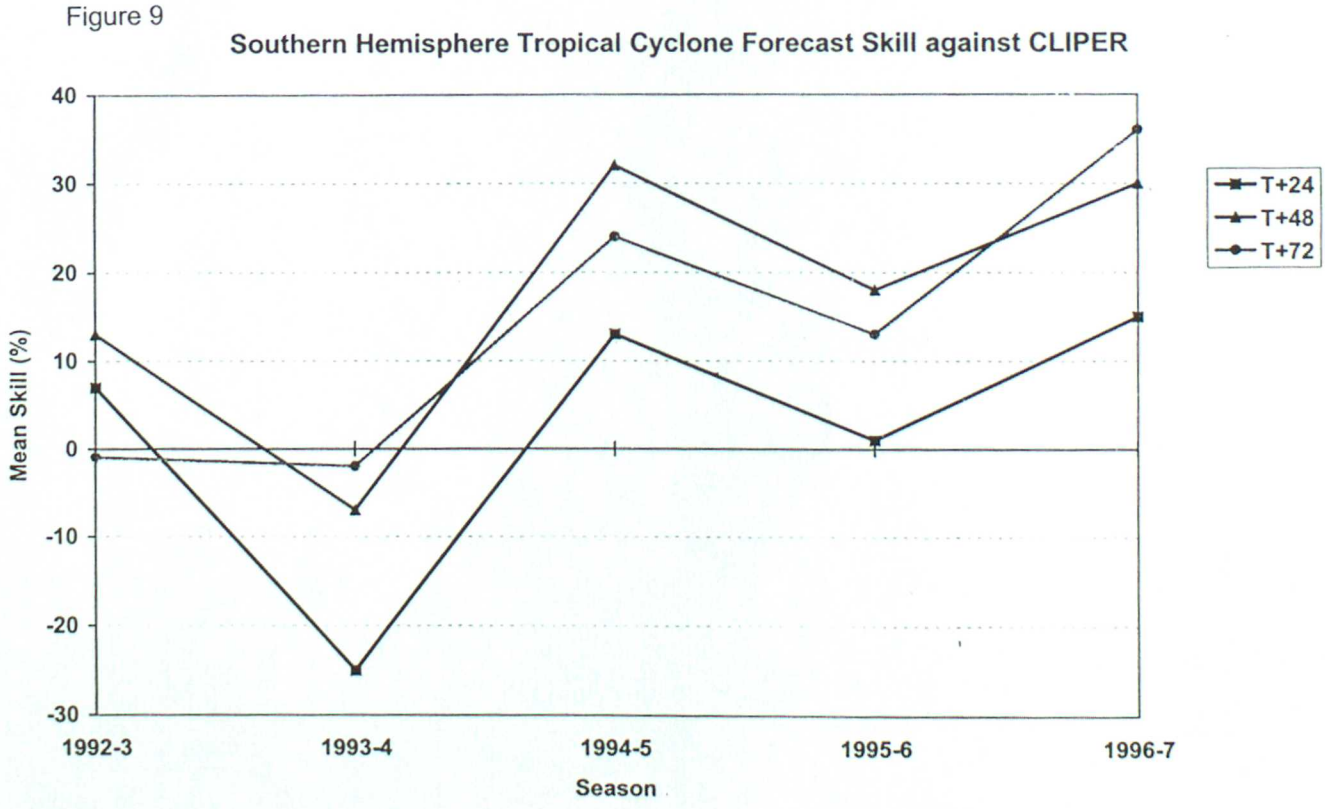


Figure 10

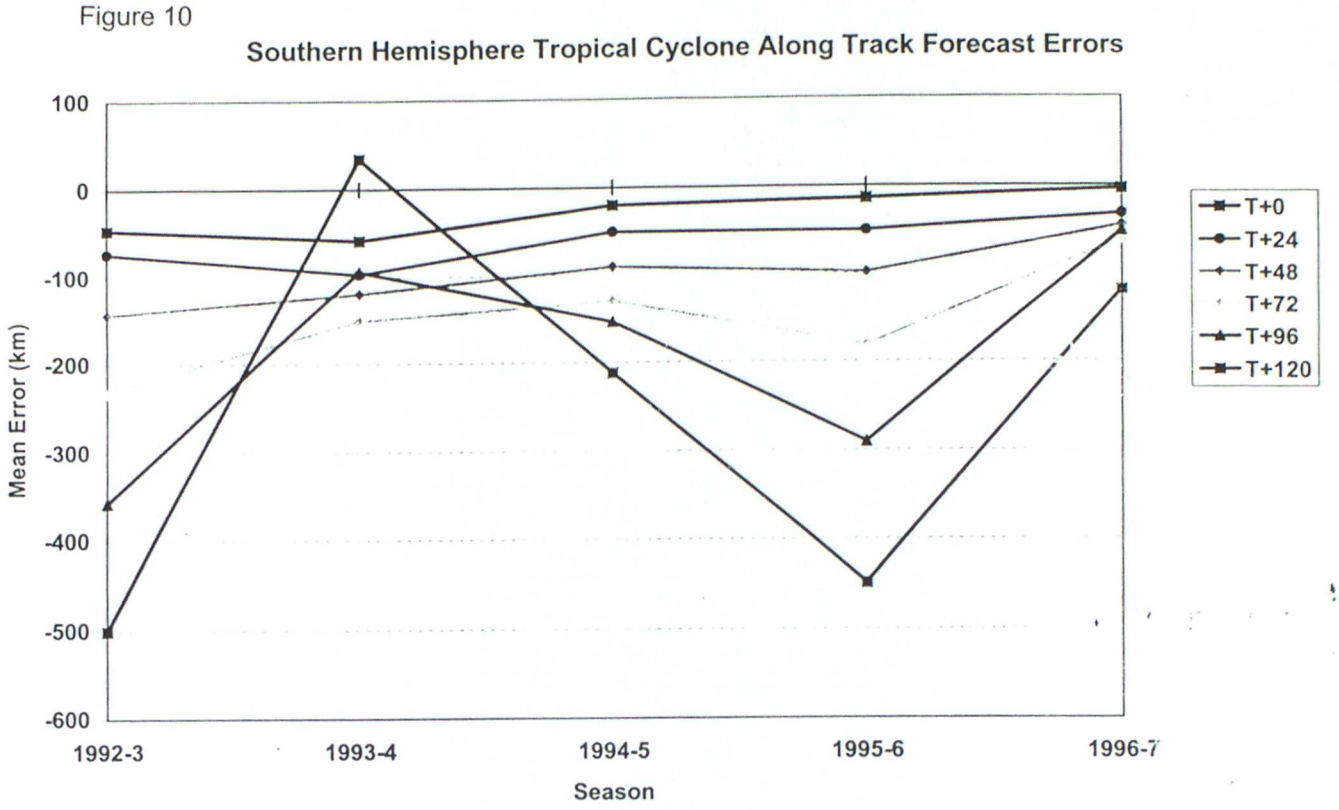


Figure 11